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Maine Agricultural Experiment Station

BULLETIN No. 62. APRIL, 1900.

THE MAINE EXPERIMENT STATION.

This Bulletin contains a brief account of the Maine Agricultural Experiment Station from its establishment in 1885, and a summary of some of the more important experiments undertaken, the results obtained, and the conclusions reached.

Requests for the Bulletins should be addressed to the
Agricultural Experiment Station,
Orono, Maine.

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MAINE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

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THE MAINE EXPERIMENT STATION.

Chas. D. Woods.

The Legislature of 1885 enacted the law establishing the Maine Fertilizer Control and Agricultural Experiment Station. The purpose of the Station was defined in Section 1 of the Act (Chapter 294 Public Laws of 1885) as follows: "That for the purpose of protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds, and for the purpose of promoting agriculture by scientific investigation and experiment, the Maine Fertilizer Control and Agricultural Experiment Station is hereby established in connection with the State College of Agriculture and Mechanic Arts."

This act was approved by the Governor March 3, 1885, and early in April the Station was organized with a Board of Managers consisting of:

Prof. Walter Balentine, Professor of Agriculture in the Maine State College; Hon. Z. A. Gilbert, North Greene, Secretary of Maine Board of Agriculture; Benj. F. Pease, Cornish; Hon. S. L. Boardman, Augusta; and William Downs, Sebec. The officers of the Station consisted of Whitman H. Jordan, Director and Chemist; Jas. M. Bartlett, Assistant Chemist; Gilbert M. Gowell, Superintendent of field and feeding experiments.

The Station was dependent for its quarters upon the hospitality of the Maine State College. A chemical laboratory was partitioned off from the main college laboratory and supplied with apparatus. Part of the dairy room of the college was fitted up with apparatus for use in experiments involving the handling of milk. A part of the new barn just erected by the college was turned over to the Experiment Station for feeding experiments and was fitted up with stalls, scales, etc. Field experiments were started by laying off about three acres of land into plots, and box experiments for growing plants were also begun.

While the principal object of the establishment of this station was the maintenance of a fertilizer control, in the first months of its existence lines of investigation were entered upon which have been followed by the Station from that time.

Dr. Jordan was Director of the Station from 1885 to June 30, 1896, when he resigned to take the directorship of the New York Experiment Station. Mr. James M. Bartlett was appointed assistant chemist at the establishment of the Station and a year later Mr. Lucius H. Merrill was also appointed as assistant chemist. Both of these gentlemen have been associated with the Station continuously since their first appointment. Mr. Gilbert M. Gowell was appointed superintendent of field and feeding experiments and he still continues with the Station in the department of stock breeding and poultry.

THE REORGANIZATION OF THE STATION.

The Maine Fertilizer Control and Agricultural Experiment Station existed about two and a half years and issued twenty bulletins and three reports, the former being published only in the leading papers of the State and the later as a part of the report of the Maine Board of Agriculture. Upon the passage by Congress of what is known as the Hatch Act, establishing agricultural experiment stations in every state, the Legislature of 1887 repealed the law of March 3, 1885, by an act which took effect October 1, 1887. It was expected at the time this act was passed, that by October first a station would be in operation under the provisions of the national law. This did not prove to be the case, owing to the failure of Congress to appropriate money, and had not the College assumed the risk of advancing the funds to pay the expenses of the Station, work would have ceased on the date in which the old station law stood repealed. As it was, work was continued until January, 1888, when the station force disbanded to await the action of Congress. It was not until after the passage of the deficiency bill early in February, 1888, that funds became available for the payment of the expenses of the year 1887-1888. Prior to this, the Maine Legislature of 1887 had accepted the provisions of the Hatch Act on the part of the State, and at the meeting of the College Trustees in June, 1887, the present Station was organized as a department of the College by the election of a director and two other members of the staff of officers.

At a meeting of the trustees, held February 16, 1888, a general plan for carrying out the provisions of the Hatch Act, involving the expenditure of $15,000 per annum, was presented to the Board of Trustees and was accepted by them, and the development and management of the Station under this plan was placed in the charge of a Station Council, made up of the President of the College, the Director of the Station, the heads of the various departments of the Station, three members of the Trustees and a representative from the State Board of Agriculture, the State Pomological Society and the State Grange.

The Station Council meets once a year and out of town members have their travelling expenses paid. At this meeting, the Director and other members of the station staff outline the work which has been undertaken in the past year and make recommendations for the following year. Such of these as commend themselves to the Station Council as well as suggestions from that body are approved and the Director is instructed to carry them out in detail. The appointment of members of the staff is made by the Trustees, and the recommendations of the Council are subject to their approval.

The Director is the executive officer of the Station and passes upon all matters of business. The members of the staff have charge of the lines of work which naturally come under their departments.

RELATION OF THE STATION TO THE UNIVERSITY.

When the legislature accepted the Hatch grant, it made the Experiment Station a part of the University. As the University is a state institution, it (including the Experiment Station) is under the same inspection as other departments of the State. The agriculture of the University is organized as the College of Agriculture, and includes both the instruction in agriculture and the work of investigation. The Professor in charge of the College of Agriculture is also the Station Director. Formerly the Experiment Station had a farm of about thirty acres and the remainder of the land was under the management of the University. In 1897, the whole farm was placed under the management of the Station. Its accounts are kept entirely distinct from the University and from the Hatch fund accounts. Both the University and the Hatch fund make appropriations, one for the privileges of instruction, the other for maintaining the experimental work. By this consolidation there was made a marked reduction of the expenses of the farm. After the College of Agriculture has used what facilities it may need for the purpose of instruction and the Experiment Station has used the land and animals needed for investigations and experiments, the remainder of the farm and livestock are handled for profit.

EQUIPMENT OF THE STATION.

The equipment of the Station consists of an office and laboratory building 60x25 feet and a wing 20x22 feet, constructed of brick with granite trimmings. The basement and first floor of this building are devoted to chemical laboratory purposes and the upper floor contains the laboratory of the veterinarian and the station offices.

In this building there are thoroughly equipped analytical laboratories for investigations of foods and feeding stuffs, fertilizers, soils, etc.

The Horticultural Building consists of a head-house, three green houses and a potting house. The plant covers over 6,000 square feet of surface and is used for the purpose of investigation and that of instruction. The head house contains the offices of the professor of horticulture and his assistant, work room, store room, and photographic rooms, as well as rooms for the station janitor.

The Dairy Building is a wooden building 50x42 feet, containing on the first floor a butter room, a cold storage room, a cheese room, a milk room and a boiler room. On the second floor is a lecture room, offices, and a cheese curing room. The apparatus includes hand and power separators of several different forms, creamers, hand and power churns and butter workers, cream and cheese tempering vats, weighing tanks, hand and power Babcock milk and cream testers of different makes, Russell pasteurizing apparatus, milk aerator, and the other appliances necessary. Power is furnished by a 6-horse power engine and by a baby tread horse power. This building is used by the Station and the College of Agriculture.

The upper barn is 40x100 feet. It has a solid stone foundation, resting directly upon the underlying ledge. The tie-up is on the south side of the main floor, and contains seventeen stalls, solidly constructed of birch. The barn contains scales for weighing experimental cattle, bins for the rations of experimental animals, rooms for grain, for storage and for digestion experiments, and a silo. The walls and partitions are of spruce sheathing.

The lower barn is 50x100 feet and has a storage capacity of 150 tons of hay. It contains a tie-up recently rebuilt, consisting of twenty-six stalls of a new and improved pattern, two grain rooms, two bull rooms, nursery, calf room, and silo. The silo is thirty-six feet deep and will contain 100 tons of cut corn. The basements of the barns contain manure cellars, store rooms and pens for swine.

The other buildings consist of a hospital barn, 25x40 feet; a two-story tool house, 25x60 feet; a horse barn 30x40 feet; sheep barn 20x120 feet; poultry breeding house, 16x150 feet; twelve poultry brooder houses, 8x10 feet. The farm contains eighty acres under cultivation and about forty acres in pastures and paddocks, varying amounts of which are used for experimental purposes. The livestock consists (April, 1900) of 5 horses; 32 cows; 20 calves and yearlings; 2 bulls; 48 swine and pigs; 67 sheep and lambs; 500 hens. Part of all the above are under experiment.

The Station has quite an extensive collection illustrating the economic botany and entomology of the State. The Station library conists of 1,200 volumes. In addition to its own books, the Station has access to the scientific library of the University and also to the State library at Augusta.

The Station is well equipped in apparatus, particularly that which has to do with chemical, botanical, entomological and horticultural investigations. The farm department is unusually well supplied with modern farm machinery.

INCOME OF THE STATION.

The revenue of the Station prior to 1888 was $5,000 per annum from the State, and fertilizer fees, the total income being something over $6,000 a year.

At present, the annual income of the Station is about $22,000, $15,000 of which comes from the Hatch fund, something over $5,000 from the fertilizer and feeding stuffs control, and the remainder from miscellaneous business and sales of produce. The State makes no appropriation for the State. Its funds come entirely from the National Government and from fees and sales of produce.

THE OBJECT OF THE STATION.

The purpose of the experiment stations is defined in the act of Congress establishing them as follows:

"It shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural and artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

INSPECTIONS.

In accepting the provisions of the act of Congress, the Maine Legislature withdrew the state appropriation for the maintenance of the Station, and thereby did away with the original purpose of the Station so far as it related to the "protection from frauds in commercial fertilizers, and from adulterations in foods, feeds and seeds." In place of this, special laws regulating the sale of commercial fertilizers, concentrated commercial feeding stuffs and agricultural seeds, and the inspection of chemical glass-ware used by creameries, have been enacted. The Director of the Station is the executive officer of these laws; the Secretary of Agriculture is the prosecuting officer. The cost of the fertilizer inspection is borne by a brand tax, that of the feeding stuff inspection by a tonnage tax and that of chemical glass-ware by a charge for calibration.

DISSEMINATION OF INFORMATION.

The annual report and bulletins of the Station cover its operations and give a full account of all its work. Up to April, 1900, the Station has published 90 bulletins and 15 annual reports, making a total of nearly 3,500 pages of printed matter. These publications are regularly sent to about 8,000 persons resident in the State, and 1,500 outside of the State. The special calls for the bulletins require an edition of about 10,500 copies. The Station has 2,000 copies of its annual report and 10,000 copies are distributed by the Board of Agriculture bound with its report.

Each month the Station issues a special newspaper bulletin giving the meteorological report for the month, and from time to time it issues newspaper bulletins on special topics which are very generally printed by the press of the State. In a few instances the Station has sent posters on important matters, to railway stations, post offices, granges, etc., which have been very generally displayed.

The Station has a large correspondence chiefly with practical farmers in the State. Careful attention is given to all inquiries and it is believed that in this way the Station is increasingly helpful to the farmer. The Director and three members of the Station staff do more or less work in farmers' institutes and other lectures. While it is believed that this work is helpful, no more of it is done than seems to be necessary, as it encroaches upon the work of investigation.

THE WORK OF THE STATION.

While the Station carries on co-operative work, such as orcharding, blueberry culture, and field experiments with farmers in different parts of the State, most of its work of investigation is from necessity, carried on in its own laboratories, greenhouses, barns and fields. Its special investigations have been along the lines of the nutrition of plants, the nutrition of animals (including man), and injurious insects and fungi.

SOME OF THE MORE IMPORTANT INVESTIGATIONS AND THEIR RESULTS.

Detailed accounts of the work of the Station have been given in its publications; nevertheless it seems appropriate to briefly summarize some of the leading experiments and the results obtained. In thus doing no reference is made to the report or bulletin in which they were described. The report of 1896 contains a general index to all the publications prior to January, 1897, and the three later reports are each indexed. If any one cares to look up the original papers, they can in this way be readily found.

FERTILIZATION OF FLOWERS, WITH REFERENCE TO THE SECONDARY EFFECTS OF POLLINATION.

The subjects receiving particular attention thus far are (1) the immediate influence of pollen on the mother plant; (2) stimulating action of pollen and the effects of varying amounts; (3) agamic development of fruit.

Results: (1) Within certain restricted limits there is an immediate influence of pollen on the mother plant. The most important plants showing this influence are the pea, the kidney bean, and Indian corn. Sweet corn shows the immediate influence of foreign pollen more frequently than do the other races of corn. Cucurbitaceous and solanaceous plants have never been found to exhibit such influence. There appears to be no relation between the amount of pollen produced by a plant and the amount required for fecundation. In some species, notably the egg-plant, the bean, and the cucumber, the ovary developed in the entire absence of pollen; but in no case where pollen was withheld were perfect seeds formed. (2) The amount of pollen supplied was found to have an important bearing on the form and size as well as the quantity of fruit produced. The form and size of tomato fruits was found to be directly dependent upon the amount of pollen furnished—a small amount invariably resulting in small and deformed fruit. (3) Indications point to the possibility of distinct effects from two male parents when pollen is applied to the same stigma at different times.

EXPERIMENTS WITH THE TOMATO.

With the tomato the following questions were considered: Effect of early setting in the field; effect of trimming the vines; effect of bagging the fruit to induce early ripening; the effect of crossing; the cumulative effect of culture under glass. *Results:* It was found that a chill to tomato plants after setting is not necessarily fatal to success, and that, other things being equal, the earliness and productiveness of tomatoes are in direct ratio with the earliness of setting in the field. Trimming the plants, after a part of the fruit had set, increased the yield by more than one-third. The results from bagging the fruit were in general of a negative character. Crossing between small fruited plants of prolific habit and the ordinary large fruited type was found to be a promising method of securing a valuable type for localities where the season is short. The increase in yield of the Lorillard-peach cross over that of the pure Lorillard was nearly 50 per cent. A derivative hybrid between Lorillard and currant produced a type of special excellence for forcing. In some instances seed from plants grown under glass gave better results in house culture than did seed of the same variety grown in the field. Results were not uniform, however, and there appeared to be distinct varietal differences.

STUDIES WITH THE CABBAGE.

Cabbage studies included investigations as to the importance of deep setting of the plants; the effect of frequent handling; the effect of trimming at the time of setting. *Results:* Contrary to the general notion concerning the treatment of "leggy" plants, it was found that depth of setting had very little influence upon the size of the head. Plants handled three or more times invariably gave better results than those handled once or twice before the transfer to the field. Frequent transplanting increased the average size of the heads. Handling the plants in pots before setting in the field increased the percentage of marketable heads; but trimming the plants at time of setting appeared to be of no special importance.

EGG PLANT.

Egg plant studies included methods of culture; varieties; crossings. *Results:* It was demonstrated that with careful treatment the egg plant may be successfully grown in Central Maine,—the most important requisites being: early sowing; vigorous plants; late removal to the field; warm, rich soil. Most of the well-known varieties are too late for this climate, but early dwarf purple, early long purple and long white were satisfactory. Several crosses were made between white fruited and black fruited types. After four years of breeding it was found that no type sufficiently constant in color to be of commercial value was produced. There was, however, a marked increase in vigor and productiveness as a result of crossing. In the first generation the purple fruited types seem stronger in their power to transmit color to the offspring than do the white fruited types; and this law appears to hold whether the purple type is used as the male or female parent. In later generations the inherent strength of the white fruited types appears more strongly than in the first. In all cases the white fruited types appear stronger in the power to transmit form and productiveness.

CAULIFLOWER.

Work with the cauliflower included studies of the relative influence of pot and box culture of young plants; the effect of trimming at time of setting in the field; the effect of mulch as compared with frequent cultivation; a comparison of varieties. *Results:* Plants handled in pots were kept at a more nearly uniform rate of growth and produced a higher percentage of marketable heads,—this difference in some cases amounting to 20 per cent. As a result of trimming it was found that there was practically no difference in earliness nor in the size of head, while as a rule the per cent of heads formed was greater from plants not trimmed. In no case were as satisfactory results obtained from mulching as from frequent cultivation. Nearly all of the leading varieties have been grown, and it is evident that the cauliflower may be successfully cultivated in this region. The most valuable sorts are of the Dwarf Erfurt and Snowball type with Algers for late in the season.

RADISH.

With the radish, the principal questions considered have been the relative value of large and small seed; the effect of sub-watering in the greenhouse; the influence of different temperatures on period of maturity. *Results:* Large seed were found to produce from 30 to 50 per cent more first-class roots than did small seed from the same lot. The sub-watered section of the bench produced 12 to 16 per cent more first-class radishes than did the surface watered section. There was a much greater loss from damping off on the surface watered section. The crop matured earlier and was of better quality when grown in the tomato house, with a night temperature of 80 degrees, than when grown at a lower temperature.

THE PRODUCTION OF FOOD MATERIAL BY VARIOUS FODDER AND ROOT CROPS.

Several varieties of fodder corn and roots were grown to determine the relative amounts of digestible dry material produced. *Results:* The large variety of fodder corn greatly excelled the other crops in the production of total and digestible dry matter. The crops which rank next in the production of digestible dry matter are Hungarian grass and rutabaga turnips.

THE INFLUENCE OF MATURITY UPON THE COMPOSITION OF THE CORN PLANT.

Field corn was harvested at five different periods of growth, and the products analyzed. *Results:* During the thirty days before the mature crop was harvested there was a continuous and large increase in the percentage of dry matter. This was due to an actual growth of dry matter, rather than to a drying out of the water with a diminished weight of crop. The increase was largely from the growth of starch, sugar and allied bodies.

SPRAYING.

Spraying with fungicides and insecticides has received considerable attention. Among the questions studied are the following: The effectiveness of the treatment in producing perfect fruit; the relative number of windfalls on sprayed and unsprayed trees; the preparation of spraying mixtures; the best time for spraying. *Results:* All trees sprayed with arsenical poisons had a smaller percentage of wormy fruit than did the unsprayed. Paris green was found less injurious to the foliage than was London purple or white arsenic. A mixture of 1 pound Paris green in 250 gallons of water was effective in reducing the amount of wormy fruit, but a stronger mixture (1 pound to 100 gallons) was required to kill the tent caterpillar. The number of windfalls was greatly lessened by spraying with Paris green and the proportion of wormy fruit among the windfalls was also smaller from the sprayed trees.

It was observed that most often wormy fruits from sprayed trees are entered from the side or base, while in fruits from unsprayed trees the entrance at the calyx were largely in excess. Spraying trees three times with an ammoniacal solution of copper carbonate destroyed the apple scab fungus and resulted in saving 52 per cent of the crop. The most effective fungicide used was Bordeaux mixture and this is now generally used throughout the State.

INJURIOUS INSECTS.

The department of entomology and botany was established in the Station in 1898. The work of investigation has consisted of studies in the field and laboratory of the life histories of insects and plants of economic importance. This has resulted in an increased knowledge of old enemies and means of combating them and in the working out of the complete life history of Trypeta pomonella (apple maggot) and Epochra canadensis (currant fly), and the discovery of numerous facts regarding the habits of many other insects of economic or entomological importance. Work of this character cannot well be summarized in definite statements. The results are published in the annual reports beginning with 1888.

ACQUISITION OF ATMOSPHERIC NITROGEN—NITRAGIN.

The acquisition of atmospheric nitrogen by plants has received attention. A bibliography of the subject has been compiled and the special features of soil inoculation has been studied. In carefully sterilized soil several of the "nitragin" cultures were compared with each other and with tubercles from various leguminous plants. The plants used in the work included red clover, pea, bean, vetch and soja bean. *Results:* The experiments thus far carried on do not warrant the recommendation of germ cultures for leguminous crops. In very few cases did the culture of the specific germ of any given species give better results than did a culture of a nearly related type.

BOX EXPERIMENTS WITH FELDSPAR AS A SOURCE OF POTASH.

Results: Oats were able to draw from the feldspar enough potash for a large crop of grain.

BOX EXPERIMENTS WITH PHOSPHORIC ACID FROM DIFFERENT SOURCES.

Phosphoric acid was supplied to 18 different kinds of plants in three forms, viz., (1) acid phosphatic rock; (2) finely ground Florida rock; (3) roasted redonda (a native phosphate of iron and aluminum). *Results:* Plants differ in their ability to feed upon crude phosphates. In nearly every case the availability proved to be in the order above given. The use of the acid rock hastens the maturity of the crop. The solubility of a phosphate in ammonium citrate is not always a correct measure of its actual value to the plant.

EFFECTS OF DIFFERENT FORMS OF PHOSPHORIC ACID IN CROP PRODUCTION.

Results: For the first year the largest increase of crop was produced by soluble phosphoric acid. For the second and third years without farther addition of fertilizers, better results were obtained from the plots where stable manure and insoluble phosphates had been used.

THE RELATIVE UTILITY OF DIFFERENT FORMS OF PHOSPHORIC ACID IN FIELD EXPERIMENTS.

Results: The phosphoric acid of bone and South Carolina rock was quite freely appropriated by oats, peas and corn.

EXPERIMENTS IN FEEDING LAMBS.

The effects of liberal feeding versus moderate feeding for growing early lambs was studied. The results were very much in favor of liberal feeding. The sheep and lambs payed at the rate of $71.60 per ton for the extra grain used.

EXPERIMENTS IN FEEDING COLTS.

Oats were compared with other mixed grain foods for producing growth with the result that a greater growth was produced by the mixed grains and hay than with oats and hay.

EXPERIMENTS IN FEEDING SWINE.

Many feed experiments have been made with swine. The more important questions studied were:

(1) The value of corn meal compared with whole corn for growth.

(2) Raw versus boiled potatoes for growth.

(3) The most efficient ratio of nutrients in a ration.

(4) The relation between the nutritive ratio and character of the growth.

(5) The relative value of animal and vegetable protein.

(6) The effect of much water in food upon assimilation.

(7) Experiment in feeding different breeds. Two each of Berkshires, Cheshires, Poland China, Chester white, and Yorkshires were used. The rations consisted of wheat middlings and skimmed milk, liberally fed according to age of animal. Daily growth, Cheshires, 1.23; Yorkshires, 1.14; Chester white, 1.08 pounds; Poland China, 1.01; Berkshire, 1 pound.

Results: (1) The same weight of whole corn produced almost the same growth as when the corn meal was fed.

(2) The apparent value of potatoes is not materially increased by boiling.

(3) In six feeding periods comparing wide and narrow rations, (one having a nutritive ratio of 1 : 9.2 and the other a ratio of 1 : 5.5) it took nearly one-half more food to produce a pound of growth with the wide ration than with the narrow. Rations with nutritive ratio of 1 : 6, 1 : 5.6, and 1 : 3.6, 1 : 4.4 were compared. The two latter rations produced no better growth than the two former, showing that the added protein of the very narrow rations was not advantageous.

(4) The nitrogenous rations proved to be best not only for growth but for the fattening period. A mixture of pea meal or gluten meal and corn meal was much more efficient than corn meal alone for fattening.

(5) In the case of young pigs the animal food (skimmed milk) was superior to the grains, but with the older animals the amount of digestible nutrients seemed to be the measure of value.

(6) The amount of water taken with the food appeared to have no particular effect on the growth.

(7) The digestible food consumed for a pound of growth was as follows: Cheshires, 2.88 lbs; Poland China, 2.73 lbs; Yorkshire, 2.55 lbs; Chester white, 2.5 lbs; Berkshires, 2.45.

In the early stages of the experiment much less food was required for a pound of growth than in the later. Berkshire and Chester whites made a larger part of their growth during the first three months.

DIGESTION EXPERIMENTS WITH SHEEP.

Since the organization of the Station, digestion experiments with sheep have formed a prominent feature of its work. The experiments have been largely with the forage crops, grown in this State, although several mill products have been tested with other work. Seventy-one different digestion experiments with native or cultivated hays or grasses; 24 experiments with dry corn fodder; 20 experiments with silage corn; 10 experiments with roots and 20 with mill products have been made. The summary of the results of the digestion experiments then completed is given in the annual report of this Station for 1897.

In addition to determining digestion coefficients, in many cases other problems have been studied such as the relative digestibility of early and late cut hay, of green and dried grasses; of mature and immature corn fodder and silage; of fodder and silage from different varieties of corn and of the oat plant in different stages of maturity.

THE VALUE OF MANURE RESIDUE FROM CORN MEAL AND COTTONSEED MEAL WHEN FED TO SHEEP.

Results: The amounts of nitrogen, phosphoric acid, and potash in the manure residue stand in direct relation to the amounts of the same ingredients in the food. The urine contained nearly one-half the potash of the total excrement, one-half to three-fourths the nitrogen, but no phosphoric acid.

EXPERIMENTS IN FEEDING STEERS FOR GROWTH.

(1.) A comparison of the economy of feeding a ration of hay and corn meal with a ration of oat straw, corn meal and cottonseed meal. *Results:* The steers fed the oat straw and mixed grain ration made the cheaper growth. The two rations contained about the same digestible nutrients and produced about the same amount of growth, the difference being in the cost of the rations.

(2.) Economy in quantity and composition of the foods used. Ten steers about eighteen months old of uniform size were divided into five pairs and fed five different rations. A, a maintenance ration; B, a moderate but wide grain ration; C, a moderate well balanced ration; D, a liberal well balanced ration; E, oat straw substituted for hay with moderate, well balanced grain ration. *Results:* It required nineteen pounds hay to 1,000 pounds live weight to maintain an animal without loss. The cost of producing a pound of growth was least when a liberal well balanced ration was fed. The substitution of nitrogenous foods in the rations greatly diminished the cost of production.

(3.) A comparison of the feeding value of corn silage with hay. Six steers were used in the experiments. Moderate grain rations were fed. *Results:* A pound of digestible matter from the corn silage produced somewhat more growth than a pound of digestible matter from the hay, but the difference was slight. The digestible matter appeared to be the measure of value of the foods.

THE RELATION OF FOOD TO THE GROWTH AND COMPOSITION OF THE BODIES OF STEERS.

The experiment had for its object a study of the effect of widely different rations upon the rate of growth and composition of the bodies of steers. Beginning at the age of four to six months, two pairs of steers were fed from seventeen to twenty-seven months on rations differing widely in their nutritive ratio, one ration having a ratio of 1 : 5.2 and the other 1 : 9.7. One pair ate 1884 pounds of digestible protein in the same time the other pair ate 1,070 pounds.

One steer of each pair was slaughtered and analyzed at the end of seventeen months feeding, the remaining steers being fed for ten months longer, when they were killed and analyzed. The chemical analysis included the entire bodies, excepting the skin and the contents of the stomach and intestines.

Results: At the end of fifteen months feeding, the pair of steers fed on the ration richer in protein had gained 221 pounds of live weight more than the pair fed the ration less rich in protein. The later growth with two steers showed a difference in favor of the ration less rich in protein.

The relative weights of organs and parts of the body was practically the same with the steers of the same age, independently of the ration.

The kind of growth caused by the two rations, viz., the proportions of water, protein, fat and ash, was not materially different with the steers of the same size. This is true whether we consider the entire bodies, the dressed carcasses or the edible portions of the carcasses. With steers fed for the same time, the composition of the entire bodies, the proportion and composition of the carcasses, and the proportions and compositions of the edible parts were practically alike.

The older pair of steers, viz : those fed for ten months longer time, contained a smaller proportion of water and a larger proportion of fat than the younger animals.

The older animals furnished five pounds per hundred more of water-free edible material than the younger animals. This is equivalent to a difference of twelve pounds of fresh, edible meat.

EXPERIMENTS WITH COWS.

An experiment in feeding wide and narrow rations to cows for milk production. Equal amounts of digestible matter were fed in each ration. The nutritive ratio of one ration was 1 : 12.3, the other 1 :6.7. *Results:* The general appearance of the cows was best when fed the nitrogenous ration and the yield of milk was 1-5 to 1-2 larger. The milk was some richer and the daily yield of milk solids was thirty to forty per cent larger on the nitrogenous rations than the milk ration.

Average daily yield milk solids on nitrogenous ration.	3.07 lbs.
Average daily yield milk solids on wide ration.......	2.28 lbs.

	Solids—%	Fat—%
Average composition of milk on nitrogenous ration	14.11	4.83
Average composition of milk on wide ration.....	13.54	4.34

AN EXPERIMENT TO TEST BREEDS OF DAIRY COWS.

The breeds tested were Holsteins, Ayrshires and Jerseys. The experiment continued two years. The following points were studied: (1.) Amount of food and nutrients. (2.) Yield of milk, solids, fat, cream and butter, and relations in quantity which these sustain; and (3.) The food cost of milk, milk solids, fat, cream and butter and incidentally the composition of the whole milk, skimmed milk, and butter milk from the different animals.

Results: (1.) The average amount of water-free food consumed daily for each animal was: Holstein, 27.4 pounds; Ayrshire, 24.7 pounds; Jersey, 28.3 pounds.

(2.) The annual yield of milk solids was: Holsteins, 1,014 pounds; Ayrshire, 848 pounds; Jersey, 827 pounds; and of butter fat, Holstein, 285 pounds; Ayrshire, 233 pounds, and Jersey, 297 pounds. Milk required for a pound of milk solids, Holstein, 8.3 pounds; Ayrshire, 7.8 pounds; Jersey, 6.6 pounds; for a pound of butter fat, Holstein, 29.4; Ayrshire, 28.3; Jersey, 18.2.

(3.) The cost of a quart of milk, reckoning the cattle foods at market prices was: Holstein, 1.83 cents; Ayrshire, 2.03 cents; Jersey, 2.42 cents. The food cost of a pound of milk solids was for Holstein, 7.09 cents; Ayrshire, 7.45 cents; Jersey, 7.44 cents; of a pound of butter fat, Holstein, 25.22 cents; Ayrshire, 26.62 cents; Jersey, 20.43 cents.

The average composition of the milk for the two years was:

	Solids—%	Fat—%
Holstein	12.22	3.47
Ayrshire	12.98	3.67
Jersey	15.24	5.50

The loss of fat in the skimmed milk was least for the Jerseys. Solids of skimmed milk were: Holstein, 9.50%; Ayrshire, 10.40%; Jersey, 10.50%.

AN EXPERIMENT TO COMPARE MAINE FIELD CORN SILAGE WITH SOUTHERN CORN SILAGE.

Results: The Maine field corn silage was found to have nearly ⅓ more digestible matter than the silage from the immature southern corn.

In the feeding trial, thirty pounds of the Maine field corn silage produced more flesh and milk than forty pounds of the southern corn silage.

AN EXPERIMENT TO COMPARE A LARGE RATION OF HAY WITH A MEDIUM RATION.

The rations consisted of (1) 13 pounds hay, 25 pounds silage, 7 pounds grain, (2) 8 pounds hay, 25 pounds silage, 7 pounds grain.

Results: The ration with the larger amount of hay proved the more efficient.

AN EXPERIMENT TO COMPARE THE FEEDING VALUE OF WHEAT MEAL WITH CORN MEAL.

Ration 1 consisted of hay, 18 pounds; wheat meal, 5 pounds; cottonseed meal, 2 pounds; and ration 2 of hay, 18 pounds; corn meal, 5 pounds; cottonseed meal, 2 pounds.

Result: The wheat meal in the combination was somewhat more efficient than the corn meal, and at about the same price can be economically substituted for it. The cows gained in weight on the wheat meal ration and produced slightly more milk than on the corn meal ration.

AN EXPERIMENT TO COMPARE GLUTEN MEAL WITH COTTON-SEED MEAL FOR MILCH COWS.

Results: The two foods proved to have equal efficiency when fed in amounts to furnish equal quantities of digestible matter.

AN EXPERIMENT TO COMPARE GROUND OATS WITH WHEAT BRAN AS FOOD FOR MILCH COWS.

Results: The ground oat ration produced slightly more milk, solids and fat than the bran, and when they can be purchased at about the same price make an excellent substitute for it.

AN EXPERIMENT TO SUBSTITUTE SILAGE FOR A PART OF THE GRAIN RATION OF MILCH COWS.

The silage used was the so-called Robertson mixture, consisting of matured corn (ears glazed), sun flower heads and horse beans. Six cows were used. The rations fed were: (1) Hay, 15 pounds; silage 20 pounds; grain, 8 pounds. (2) Hay, 15 pounds; silage, 35 pounds; grain, 4 pounds.

Results: Ration 2 in which silage was substituted for a part of the grain ration was fully equal to ration 1, producing as much milk and a greater gain in weight of cows.

AN EXPERIMENT IN FEEDING NUTRIOTONE.

This is a patent food or medicine, claimed by manufacturers to stimulate growth and milk production.

Five cows were fed three periods of twenty-one days each liberal rations of hay and grain. The rations were weighed. In the second feeding period, two spoonfuls of nutriotone (according to directions in the package) were added to the grain ration.

Results: The nutriotone had no visible effect. The cows in twenty-one days without nutritone produced 2,281 pounds milk and 101 pounds fat. The cows in twenty-one days with nutriotone produced 2,264 pounds milk and 101 pounds fat.

AN EXPERIMENT TO TEST THE EFFECT OF FOOD ON THE HARDNESS OF BUTTER AND COMPOSITION OF BUTTER FAT.

The primary object of the experiment was to study the effect of liberal rations of corn gluten meals containing large and small amounts of fat on the hardness of butter, and butter fat. Eight different gluten meals were used, varying in fat content from one per cent to nineteen per cent, also in other feeding trials gluten feed, flax meal, and cottonseed meal. Eleven cows were employed and twelve tests made. The feeding periods were from two to four weeks each and extended over three years. *Results:* The gluten meals with high fat content produced soft butter with fat of low melting point and high iodine number.

Gluten meals containing very small amounts of fat or oil, made butters of about normal firmness. When tallow was added to the ration, the hardness of the butter was somewhat increased. Cottonseed meal produced a hard butter. The hardness of butter can be regulated to a large extent by the food of the cows.

THE MINERAL INGREDIENTS OF MILK.

Analyses were made of the ash of the milk, from six cows, representing three breeds. *Results:* The differences in composition were great, even with cows of the same breed. The potash and phosphoric acid were the most variable constituents.

THE FAT GLOBULES OF MILK.

The milk of five cows, representing three breeds, was examined and the relative size and number of the globules determined, in both the whole and skimmed milk. *Results:* The globules of the milk from the Jersey cows were much larger than in the milk from the cows of the other breeds. In every case the globules of the skimmed milk were less than one-half the size of those from the whole milk.

EFFECTS OF TUBERCULIN ON TUBERCULOUS COWS.

The tests were applied to a herd of fourteen cows and cover periods of from one to two years. *Results:* The tests together with the autopsies indicate that tuberculin is a very delicate agent for determining the presence of tuberculosis. It is very doubtful if cows ever react under a properly made tuberculin test unless they have tuberculosis. On the other hand, it is very evident that cows sometimes have tuberculosis, or, at least, tuberculosis growths in their bodies, and yet fail to react under the tuberculin test.

A NEST BOX FOR KEEPING INDIVIDUAL EGG RECORDS.

An attempt is being made to establish families of hens that shall excel as egg producers. To do this it is necessary to make careful selections for which the individual records must serve as a basis. The nest box devised is believed to serve the purpose admirably.

THE NUMBER OF LAYING HENS THAT CAN BE PROFITABLY KEPT IN ONE PEN.

Varying numbers of hens were confined in pens having each 160 feet floor space. *Results:* The maximum production per hen was obtained when the least number of hens (15) was confined to one pen; but the pens containing twenty birds gave a greater total net profit than did those containing any greater or less number of birds.

EXPERIMENTS UPON THE DIGESTIBILITY OF BREAD WITH MEN WITH SPECIAL REFERENCE TO PROTEIN.

Results: Digestibility of protein of

White bread and milk	92.8%
Graham bread and milk	88.5%
Entire wheat bread and milk	91.9%

THE DIGESTIBILITY OF BREAD ALONE.

A continuation of the work outlined above. The approximate availability of the nutrients of butter, milk and sugar being known, a correction of the first results obtained was made possible.

Results: Digestibility of protein of

White bread alone	88.3%
Graham bread alone	77.0%
Entire wheat bread alone	86.6%

DIETARY STUDIES.

Investigations were carried on at the College Commons for a period of 209 days. *Results:* The cost of the animal foods was 69 per cent of the total food cost. The freer use of milk did not increase the gross weight of food eaten. The increased consumption of milk had the effect of materially narrowing the nutritive ratio of the dietary, while at the same time the cost of the dietary was diminished. Milk should not be regarded as a luxury, but as an economical article of diet.

SKIMMED MILK OR WATER IN BREAD MAKING.

An experiment designed to show the increased value of bread in which skimmed milk has been substituted for water. *Results:* Skimmed milk bread contains more protein than water bread and is as completely digested.

PUBLICATIONS OF THE STATION.

The Station has purchased 15 annual reports and 88 bulletins. The first 26 bulletins were newspaper bulletins published prior to the reorganization of the Station in 1888. All matter of permanent importance was included in the reports. The first number of the present series of bulletins was published May 1, 1889.

The titles of the principal papers in the reports and of the bulletins follow. The mark * preceding a report or bulletin denotes that the edition is nearly or quite exhausted. Copies of the publications not marked * will be sent on application so long as the numbers on hand will allow. The reports of this Station are bound with those of the Secretary of Agriculture, so that anyone having the "Agriculture of Maine" has also the report of the Station for that year.

*REPORT FOR 1885.

Inspection of fertilizers.

REPORT FOR 1886.

Inspection of fertilizers. Wood ashes. Harbor mud. Ashes vs. acid for treating ground bone. Purchase of fertilizing material. Manure residue of corn meal and cotton-seed meal. Composition of cattle foods and special foods. Digestion experiments with timothy hay and corn in various forms. Feeding cotton-seed meal for milk and butter production. Feeding steers for growth.

*REPORT FOR 1887.

Inspection of fertilizers. Miscellaneous fertilizers. Experiments with fertilizers at the Station and among farmers. Analyses of feeding stuffs. Digestion experiments. Feeding experiments for milk and butter and for growth. Inquiries concerning cattle foods. Tests and varieties, grain and potatoes. Experiments in raising cream. Adulteration of molasses. Insecticides. Analytical and experimental methods.

REPORT FOR 1888.

Inspection of fertilizers. Digestion experiments with sheep. The compounding of rations for farm animals. The composition and digestibility of American feeding stuffs. Tests of varieties of potatoes, oats, barley, and peas. Germination tests of seeds. Description of the following injurious insects: Round-headed apple-tree borer; Flat-headed apple-tree borer; Oyster-shell bark louse; Apple-tree tent-caterpillar; Forest tent-caterpillar; Fall canker-worm; Eye-spotted bud-moth; Apple-tree aphis; Codling moth; Apple maggot; Ash-gray pinion; Pear-tree slug; Indian cetonia; Plum curculio; Cherry-tree plant louse; Imported currant-worm; Ivy scale insect; Black swallow-tail butterfly; Eyed elater; Hawthorn tingis; Mourning cloak butterfly; Meal-worm beetle.

REPORT FOR 1889.

Inspection of fertilizers. Composition, digestibility and yield of corn-fodder and hay from various grasses. Composition and value of various commercial feeding stuffs. The comparative digestibility of wheat bran and wheat middlings. Composition and digestibility of pea meal. The value of the digestible matter of good hay as compared with the digestible matter of corn ensilage, for milk production. The value of the digestible matter of ensilage as compared with the digestible matter of hay, for growth. Feeding experiments with swine. Tests of several breeds of dairy cows. Field and pot experiments with fertilizers. Field tests with varieties of barley, oats and peas. Seed germination experiments. Experiments with forage plants. The potato rot. Apple scab. The apple maggot. Insecticides. Hog cholera. Parturient apoplexy, (milk fever). The coefficients of digestibility for protein. Loss of food and manurial value in selling sweet corn.

REPORT FOR 1890.

Inspection of fertilizers. Tests of dairy cows. Mechanical loss of butter fat. Effect of delay in setting milk. The mineral ingredients of milk. The fat globules of milk. Tuberculosis in the college herd. Feeding experiments with colts, steers, and swine. Field experiments with fertilizers. Germination tests of seeds. Spraying experiments. Injurious insects. Meteorological observations.

*REPORT FOR 1891.

Inspection of fertilizers. Station equipment. Digestion experiments. Production of food material by various fodder and root crops. Turnips for sheep. Producing growth in lambs. Feeding experiment with colts.

Influence of food on butter. Babcock milk test for cream. Equipment of horticultural department. Notes on cabbage, tomatoes and egg plants. Spraying for codling moth and apple scab. Spraying apparatus. Fertilizer experiments. Growing grains mixed and separately. Spring and fall manuring. Meteorological observations. Jamestown weed. White radish. Yellow dock. Chess. Mosses as stock food. Ticks. Sphinx moths. Cut worms. Cotton wood dagger. Three toothed Aphonus. Predaceous water beetle. Parallel elaphidion. Brown ptinus. Goldsmith beetle. Remedies for borers. Breeding statistics.

*REPORT FOR 1892.

Inspection of fertilizers. Miscellaneous analyses. Secondary effects of Pollination. Notes on cabbages, tomatoes and egg plant. Fruit tests. Spraying experiments. Fall dandelion. Orange hawkweed. Leaf blight of pear. Black or hair mold. Anthracnose of blackberry and raspberry. Potato blight. Fall canker worm. Boll or corn worm. Chinch bug. Horn fly. Two-spotted mite. Cut worms. Meteorological observations. Testing cream and milk fat test and lactometer.

REPORT FOR 1893.

Investigation of the foraging powers of some agricultural plants for phosphoric acid. The composition of fodders and silage from the corn plant. Digestion experiments with sheep. Corn as a silage crop. Feeding experiments with cows and swine. Waste of fat in the skimmed milk by the deep-setting process. Notes on cabbages, cauliflowers, tomatoes, egg plants and potatoes. Spraying experiments. Catalogue of Maine fruits. Bean and tomato anthracnose. Potato and beet scab. The Angoumois grain moth; the lime-tree winter-moth; the apple-leaf bucculatrix; the Disippus butterfly; the May beetle; the bean weevil; the pear-blight beetle or shot-borer; the carrot-fly.

REPORT FOR 1894.

Analyses of butter and imitation butter. Field experiments with fertilizers. The profitable amount of seed per acre for corn. Digestion experiments. Feeding experiments. Notes on potatoes and corn. Notes on small fruits and on plant breeding. The orange-colored roestelia or quince rust. Diseases of oats. Night-flowering catchfly. The dichotomous catchfly. Potato scab. The snow flea. The silver fish. The ring-banded soldier-bug. The elm tree bark louse. The gooseberry plant-louse. The oblique-banded carpet beetle. The oak-bark weevil. The fall canker worm. Tuberculin as a diagnostic agent. Bulletins issued in 1894—Fruit-culture. Spraying experiments. Tomatoes. Cauliflowers. Corn as a silage crop. Potatoes. Tuberculosis and glanders. A scheme for paying for cream, etc. Foraging powers of some agricultural plants.

REPORT FOR 1895.

Investigations on the foraging powers of some agricultural plants for phosphoric acid. The profitable amount of seed per acre for corn. Sunflower heads and blackeye peas as silage crops. Feeding experiments with milch cows. The relation of food to the growth and composition of the bodies of steers. Notes on potatoes, sweet corn, peas and cabbage. Notes on plants and insects. Second blooming of pear trees. Cattle lice. The yellow woolly bear. Tapestry moth. The strawberry leaf beetle. The cucumber flea beetle. The currant fly. Bulletins issued in 1895—Important facts about corn. Inspection of fertilizers. A discussion of certain commercial fertilizers. A discussion of condimental foods. Notes on small fruits. Inspection of fertilizers.

REPORT FOR 1896.

New fittings of the cow stable. Analyses of feeding stuffs. Profitable amount of seed corn per acre. Sunflowers and English horse beans as silage crops. Tests of separators. Feeding experiments with milch cows. Effects of tuberculin on tuberculous cows. Orchard notes. Notes on winter gardening. Notes on plants. Insects of the year. A new garden Smynthurid. Dietary studies at the Maine State College. Meteorological summary. Reprints of bulletins 23 to 31. Inspection laws. General index to reports for 1885 to 1895 inclusive.

REPORT FOR 1897.

Reprints of bulletins 32 to 40. Inspections for 1897. Testing dairy products by the Babcock test. New poultry plant. Ornamenting home grounds. Acquisition of atmospheric nitrogen. Digestion experiments. Tests of tuberculin on tuberculous cows. Comparison of the temperatures of healthy and tuberculous cows. Notes on insects and plants. King-devil weed. Herd records. Meteorological observations.

REPORT FOR 1898.

Reprint of bulletins 41 to 47. Inspections for 1898. Box experiments with phosphoric acid. Analyses of fodders and feeding stuffs. Digestion experiments with sheep. Oat hay harvested at different stages of maturity. Effect of food on the hardness of butter and composition of butter fat. Effect of feeding fat on the fat content of milk. Injurious millipedes. An injurious caddice fly. Insects and plants of the year. Tuberculosis and the station herd. Nest box for keeping individual egg records. Number of laying hens that can be profitably kept in one pen. Herd records. Comparison of large and small radish seed. Effects of subwatering radishes. Blueberry in Maine. Experiments upon the digestibility of bread. Acquisition of atmospheric nitrogen. Soil inoculation. Skimmed milk vs. water in bread making. Pollination and fertilization of flowers. Meteorological observations.

NUMBERS AND TITLES OF BULLETINS OF THE PRESENT SERIES.

1. Analysis of Commercial Fertilizers for 1889.
2. The Apple Maggot.
*3. Babcock Milk Test Adapted to Testing Cream.
4. Testing Cream and Milk Fat Test and Lactometer.
5. Waste of Fat in Skimmed Milk by the Deep-setting Process.
6. Fruit Culture—Varieties.
7. Inspection of Fertilizer.
8. Spraying Experiments.
9. Tomatoes.
10. Cauliflowers.
11. Corn as a Silage Crop.
12. Potatoes.
13. Suppression of Bovine Tuberculosis and Glanders.
14. Inspection of Fertilizers.
*15. Paying for Cream by the Babcock Test.
16. Foraging Powers of Some Agricultural Plants for Phosphoric Acid.
17. Important Facts about Corn.
18. Inspection of Fertilizers, 1895.
19. Commercial Articles (1) Fertilizers.
20. Commercial Articles (2) Foods.
21. Notes on Small Fruits.
22. Inspection of Fertilizers.
23. Preservation of Cream for Market.
24. Cabbages.
25. Inspection of Fertilizers, 1896.
26. Inspection of Glassware used by Creameries and Butter Factories.
27. Peas—Sweet Corn.
28. Potato Rot—Bordeaux Mixture and Fungiroid.
29. Notes on Spraying.
30. Fertilizer Inspection.
*31. Modification of Babcock Method.
32. Three Troublesome Weeds.
33. Fertilizer Inspection.
*34. Box Experiments with Phosphates.
35. The Currant Fly.
36. Testing Seeds.
37. Feeding Stuff Inspection.
38. Fertilizer Inspection.
39. Stock Feeding Suggestions.
40. Celery.
41. Dehorning Cows.
*42. Ornamenting Home Grounds.
43. Fertilizer Inspection.
44. Feeding Stuff Inspection.
45. Fertilizer Inspection.
46. Ornamental Plants for Maine.

47. Wheat Offals Sold in Maine in 1898.
48. Feeding Stuff Inspection.
49. Care of Orchards.
50. Fertilizer Inspection.
51. Feeding Stuff Inspection.
52. The Spraying of Plants.
53. Fertilizer Inspection.
54. Nuts as Food.
55. Cereal Breakfast Foods.
56. Apple Insects of Maine.
57. Experiments With Potatoes.
58. Finances, Meteorology, Index.
59. Feeding Stuff Inspection.
60. Fertilizer Inspection.
61. Notes on Insects and Plants.

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